VIKING LABORATORIES INC.

6047

INSTRUCTION MANUAL

Gertsch
EMPIRE
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Panoramic

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Precision electrical and electronic instruments for measurement

THE SINGER COMPANY • METRICS DIVISION

MP MASTER
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INSTRUCTION MANUAL

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Gertsch

INSTRUCTION BOOK

for

MODEL RHF-1

HIGH FREQUENCY

STANDARDS RECEIVER

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6. Approximate number of hours of use
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8. Other comments

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(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

TABLE OF CONTENTS

Section		Page
I	GENERAL DESCRIPTION	5
II	INSTALLATION	6
III	OPERATING INSTRUCTIONS	7
IV	THEORY OF OPERATION	11
V	MAINTENANCE	14
VI	TEST AND ALIGNMENT PROCEDURES	14
VII	PARTS LIST	16

LIST OF TABLES

Number		Page
I	Specification	5
II	Function of Operating Controls, Indicators, and Connectors	8
III	Normal Transistor DC Voltages	15
V	Normal Stage Gains	16

LIST OF ILLUSTRATIONS

Number		Page
1	Model RHF High Frequency Standards Receiver	4
2	Typical Antenna Installation	6
3	115/230 VAC Power Conversion	7
4	Operating Controls, Indicators, and Connectors	8
5	Block Diagram	11
6	Schematic Diagram	13
7	Chassis Layout	22
8	Capacitor Locations	22
9	Resistor and Diode Locations	23

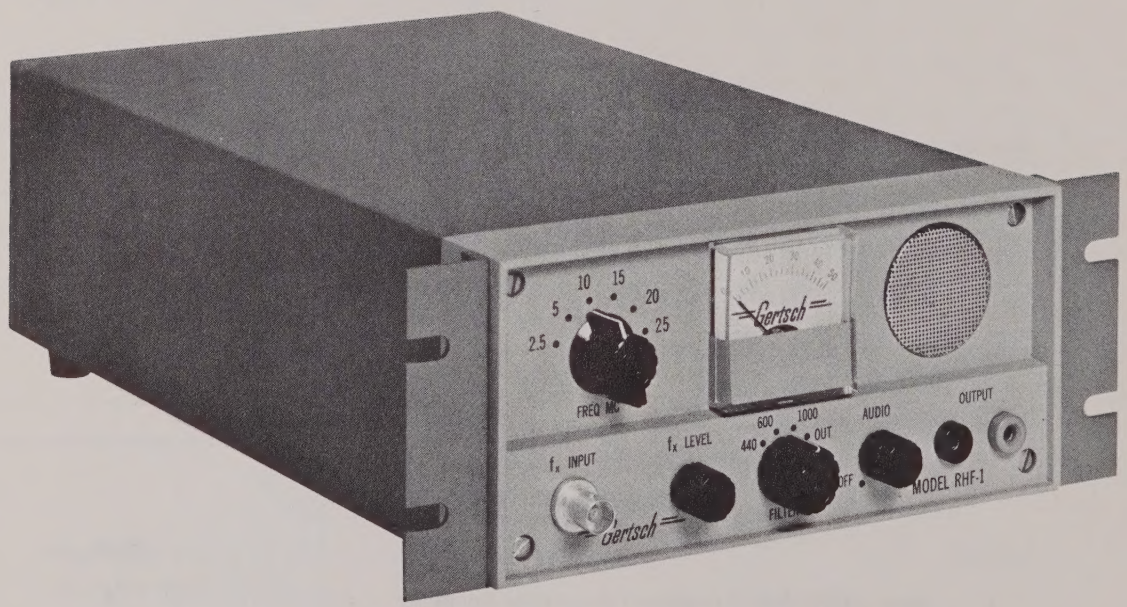


Figure 1. Model RHF High Frequency Standards Receiver

SECTION I

GENERAL DESCRIPTION

The Gertsch Model RHF-1 receives all six international frequency transmissions for calibration of oscillators and frequency standards. Other applications include precision time measurements and receiving radio propagation notices transmitted at these frequencies.

With a permanent installation and long term reception records, accuracies of up to several parts in 10^{-8} are obtainable. When used as a field or portable instrument and with short term records accuracies of a few parts in 10^{-7} are obtainable.

Each of the six frequencies is controlled by a separate crystal so that the optimum frequency may be selected with a single switch. The audio system includes filters for the 440, 600, and 1000 cycle tones transmitted by the National Bureau of Standards. With the special filter circuits switched out of the system, good audio response at frequencies below 100 cycles is provided for beat note detection.

For detection of beat notes, the instrument includes a speaker, front panel audio output jacks, a monitor meter, and rear panel connectors for an oscilloscope. The audio output jacks are connected in parallel with the self-contained speaker and provide a 100 ohm output impedance. The monitor meter, which also operates as a relative signal strength meter, is connected across the AGC circuit. The oscilloscope connectors (horizontal, vertical, and ground) are tapped off the IF amplifier output.

The receiver is an all transistorized, self-contained unit designed for bench, half-rack, or field use. Operating controls are identified and located on the front panel. The power cord and antenna connectors are located on the rear panel.

Normally, the unit is shipped for 115 VAC line power. Brackets are included for conversion to half-rack mounting. By simple replacement of jumpers on the printed circuit board, the unit may be converted for use with a 230 VAC power source. Refer to Section II for recommendations on the installation of a permanent antenna.

For field or portable use, the unit may be switched for operation with a 12 VDC power source and a random length (6 to 50 feet) wire antenna.

TABLE I. SPECIFICATIONS

Type	Single conversion, superheterodyne
Operating Frequencies	2.5, 5, 10, 15, 20, and 25 megacycles (units can be supplied with up to 3 additional frequencies, between the range of 2.5 to 25 mc)
Sensitivity	1 microvolt input
Selectivity	4 kc wide, 6 db down 20 kc wide, 60 db down
Image Rejection and Spurious Response	2.5 mc to 15 mc – 50 db 20 and 25 mc – 35 db
AGC	Output change less than 10 db with input signal of 10 to 30,000 UV
Signal-Plus-Noise to Noise Ratio	Better than 10 db (at 3 UV input)
Input Impedance	52 ohms and high impedance
Audio Output	100 mw for 3 microvolts input
Monitor Meter	Relative signal strength and zero beat indication
Audio Filters	Panel switch selects 440, 600, and 1000 cycles
f_x Input	BNC connector and attenuator on front panel
Oscilloscope Connections	Banana jacks located on rear of chassis for observation of beat frequency
Audio Output Impedance	Approximately 100 ohms (terminals on front panel)
Power Requirements	115/230 volts, 50/60 cycles at 2.5 VA, or 12 volts DC at 120 milliamperes
Dimensions	7-1/2 inches W by 3-1/2 inches H by 13 inches D

SECTION II

INSTALLATION

ANTENNA REQUIREMENTS

The Model RHF-1 Receiver has two antenna terminals located on the rear panel:

1. A 50 ohm BNC connector for a permanent antenna.

2. A HI-Z (high impedance) terminal for connection of a short wire antenna.

PERMANENT ANTENNA. The best compromise for a permanent antenna is a half wave doublet, cut to the maximum useable midday frequency and connected with RG58/U, 50 ohm, coaxial cable. Refer to figure 2 for a typical installation. Keep the antenna as far away as possible from power lines. Never cross over power lines. Where poles are used, guy the poles securely.

High Considerations. For short or medium distance reception (40 to 300 miles), the antenna height should be approximately 1/8 to 1/4 wave length. For longer distance reception (500 to 2000 miles), the antenna height should be approximately 1/2 to 3/4 wave length. When the surrounding terrain causes scattering of the sky wave, the optimum height is best determined by experiment.

Direction Considerations. For the lower frequencies (2.5, 5, and 10 megacycles) the direction of the antenna is not too critical but does become critical at the higher frequencies. To minimize the atmospheric noise which arrives from the tropics at very low angles, orient the antenna broadside to the noise source (approximately in an east-west direction).

WIRE ANTENNA

For temporary or portable use, connect a random length of wire (6 to 50 feet) to the HI-Z input and peak the signal using the ANT TRIM, located on the rear panel.

POWER REQUIREMENTS

115 VAC POWER. To operate the instrument using 115 VAC line power, make certain the POWER selection switch (located on the rear panel) is in the AC position and plug power cord into line power.

230 VAC POWER. To operate the instrument using 230 VAC power, proceed as follows:

1. Remove chassis cover from unit.

2. Unsolder and remove 115 VAC jumper wires from printed circuit board and solder 230 VAC jumper wire in place (see figure 3).

3. Replace chassis cover.

4. Make certain POWER selection switch is turned to the AC position.

5. Plug power cord in 230 VAC power line.

12 VDC POWER. To operate the instrument using 12 VDC power, proceed as follows:

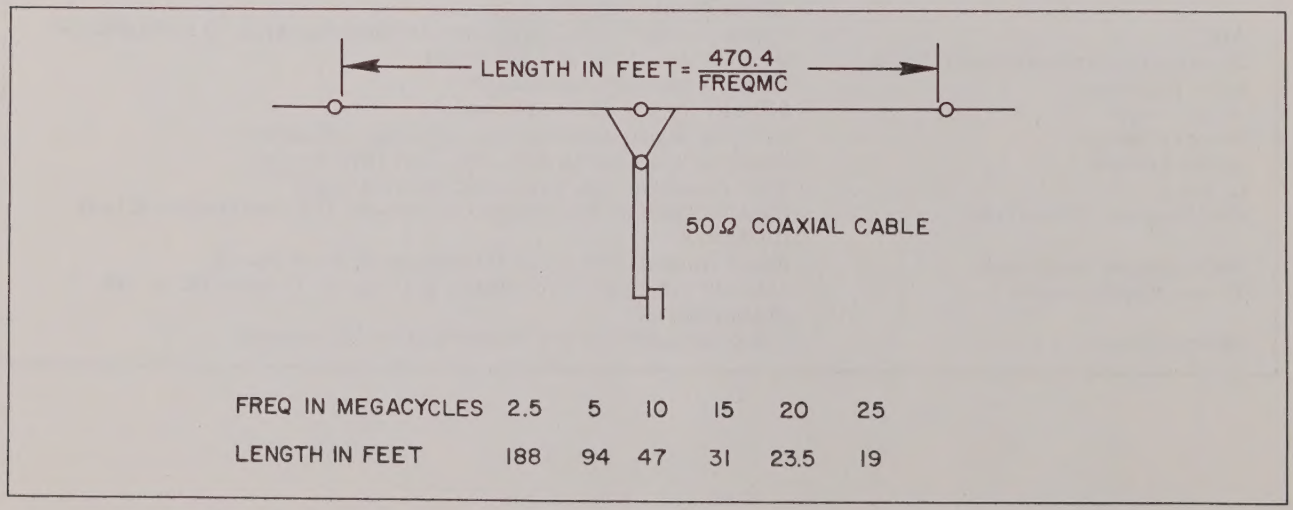


Figure 2. Typical Antenna Installation

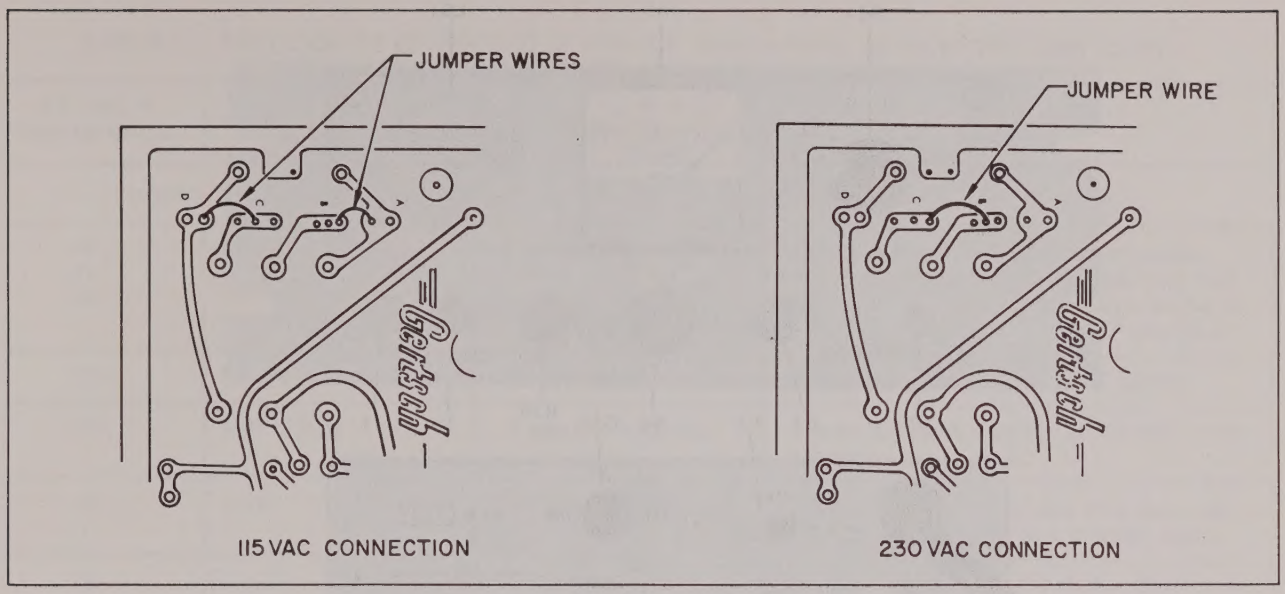


Figure 3. 115/230 VAC Power Conversion

1. Slide POWER selection switch to the DC position.

2. Connect 12 VDC power to the 12 VDC positive and negative connectors on the rear panel. The connectors are marked for proper polarity. The unit includes diode CR2 to prevent damage if power is connected with reversed polarity.

NOTE

The receiver will not operate if polarity is reversed.

3. When used with 12 VDC and a wire antenna, ground the receiver case for optimum operation.

SECTION III

OPERATING INSTRUCTIONS

OPERATION

To operate the Model RHF-1, proceed as follows (refer to Table II for the functions of the various controls, indicators, and connectors):

1. Turn AUDIO control clockwise from the OFF position. (No warm-up required.)

2. Turn FILTER switch to the OUT position.

3. Turn FREQ MC selector to the highest usable frequency.

4. Set AUDIO control to a comfortable level.

5. Adjust ANT TRIM for maximum indication on the monitor meter.

NOTE

With sufficient input level and with the AUDIO control turned to maximum, the audio section will produce square waves. This feature of the Model RHF-1 may be used to facilitate detection at very low frequency beat notes.

100 KC AND 1 MEGACYCLE OSCILLATOR COMPARISONS

1. Connect oscillator to the f_X INPUT connector.

2. Adjust f_X LEVEL control until the oscillator level approximately equals the transmitted signal level. The two levels are approximately equal when a beat note is heard.

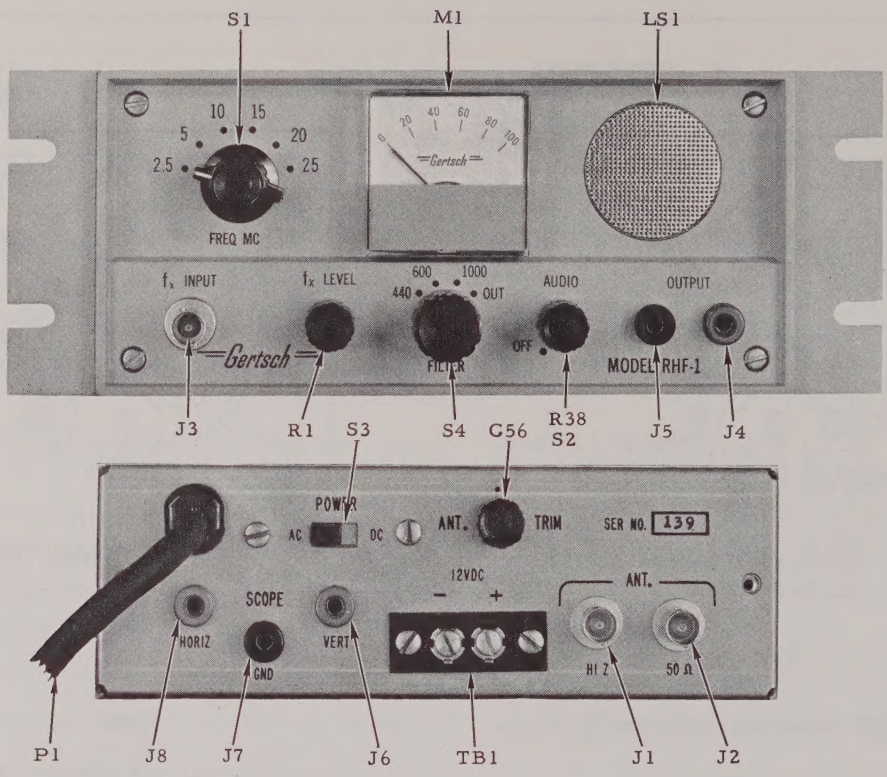


Figure 4. Operating Controls, Indicators, and Connectors

TABLE II. FUNCTION OF OPERATING CONTROLS, INDICATORS, AND CONNECTORS

FIGURE 4 REFERENCE	PANEL MARKING	TYPE OF CONTROL	FUNCTION
S1	FREQ MC	6 position rotary switch	Selects operating frequency of receiver.
J3	f_X INPUT	BNC connector	Connection point for comparison frequency.
R1	f_X LEVEL	Variable resistor	Adjust input level of comparison frequency to level of received signal.
S4	FILTER	4 position rotary switch	Selects filter for 440, 600, or 1000 cps signals, or for broad band audio.
R38 S2	AUDIO	Variable resistor and switch	Audio level control and power on-off switch.
M1		Meter	Monitor meter for observing relative signal strength and zero beat indications.
J4 J5	OUTPUT	Banana jacks	100 ohm impedance, audio output connector.
LS1		Loudspeaker	Audio monitoring.

TABLE II. FUNCTION OF OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

FIGURE 4 REFERENCE	PANEL MARKING	TYPE OF CONTROL	FUNCTION
NOTE: The following controls, indicators, and connectors are located on the rear panel.			
J6 J7 J8	SCOPE	Banana jacks	Oscilloscope connections (horizontal, vertical, and ground) for observing beat frequencies. The oscilloscope output is tapped off the output of the IF amplifier.
TB1	"+" "-"	Terminal board	Connection point for 12 VDC power.
C56	ANT TRIM	Variable capacitor	Tunes RF input circuit for use with wire antenna.
J1	ANT	BNC connector	50 ohm connector for use with a permanent antenna and 50 ohm coaxial input.
J2		BNC connector	HI-Z connector for use with a short wire antenna.
S3	POWER SELECTION	Slide switch	Switches power circuitry for either AC or DC power.
P1		Power cord and plug	AC power connection.

NOTE

If the signal amplitude from the oscillator is very large, it may be necessary to reduce the signal through an external network before application to the f_X INPUT.

3. Adjust oscillator frequency until beat note is heard in the receiver. If required, re-adjust f_X LEVEL control to obtain maximum beat note amplitude.

CAUTION

A disturbed ionosphere may produce a rapid fading on the transmitted signal and produce conditions similar to a beat.

4. Adjust oscillator frequency until zero beat note is indicated by the speaker. Then use the monitor meter to observe extremely slow beats.

5. Using a stop watch and the monitor meter, observe the number of beats for at least 100 seconds.

6. Divide the number of beats observed by the time of the observation period (in seconds).

EXAMPLE: 10 beats observed during 100 seconds.

$$\frac{10 \text{ (beats)}}{100 \text{ (seconds)}} = 0.1 \text{ cycle per second}$$

7. Divide the transmitted signal channel frequency by the cycles per second obtained in step 6.

EXAMPLE:

$$\frac{0.1 \text{ (cycles per second)}}{10 \text{ megacycles (channel frequency)}} - 1 \text{ part in } 10^8$$

8. The above example would indicate accuracy of 1 part in 10^8 for a 1 megacycle f_X INPUT. However, Doppler effect and any ionosphere changes create an uncertainty. To account for this uncertainty, the accuracy should be stated as one order of magnitude less, or 1 part in 10^7.

9. Daily measurements taken at the same time against the same oscillator and averaged for 30 days will give an accuracy of one order of magnitude better, or 1 part in 10^8.

10. For oscilloscope detection of beat notes, connect an oscilloscope to the SCOPE connectors located on the rear panel. Beat notes will appear as two concentric circles with an IF component between the circles. In the absence of beat note, the two circles will collapse to form a single circle.

440 AND 600 CPS OSCILLATOR COMPARISONS

1. Connect oscilloscope horizontal input to the OUTPUT jacks.

2. Turn FILTER switch to applicable 440 or 600 cps position.

3. Connect the oscillator output to the vertical input of the oscilloscope.

4. Adjust the oscilloscope to obtain a Lissajous pattern. Providing a sine wave is used and the phase relations are correct, a 1 to 1 frequency ratio will be displayed as a circle. A 2 to 1 ratio will be displayed as two loops and a 3 to 1 ratio as three loops.

5. Adjust the oscillator to obtain a circle or one of the loop patterns.

1000 CYCLE TIME PULSE USE

1. Connect the output of a 100 cps standard to an oscilloscope to obtain a 100 cps circle. This may be accomplished by applying the output of the standard to one set of deflection plates directly and to the other set through a 90° phase shift network.

2. Connect the vertical input of the oscilloscope to the OUTPUT jacks.

3. Turn FILTER switch to 1000 cps position.

4. The one second tick from WWV will appear as a wave extending half way around the circle and repeating every second. If the standard is accurate, the wave will appear to be stationary.

ACCURACY CONSIDERATIONS

The time and frequency signals transmitted by the National Bureau of Standards have an accuracy of one or two parts in 10^{-10}. The limiting factors for accurate comparison over long distances are, primarily, propagation error, Doppler effect, and ionospheric disturbances. For short sampling periods (approximately 100 seconds), these factors limit accuracy to the order of 2 parts in 10^{-7}. Increased accuracy accuracy depends upon long term records.

If similar comparisons are made each day for 30 days, the accuracy will improve by one order of magnitude, or 1 part in 10^{-8}. If the time pulses are employed and averaged with a clock, greater accuracies are obtainable. This greater accuracy requires that comparisons be made each day for 30 days and that the total comparison time be 24 hours.

The most reliable records for long distance reception are made when:

1. The path between the transmitter and receiver is all daylight or all darkness.

2. Day records are made with the sun at meridian at a point halfway between the transmitter and receiver.

3. Data taken during times of ionospheric disturbances is discarded.

4. The highest usable frequency is selected.

For those who may be interested in further information on the subject of time and frequency measurements, the following list of reports may be of help:

Proceeding IRE, "Special issue on nature of the ionosphere". Vol. 47, No. 2, February 1959.

"Stability of Standard Frequency Transmissions and Time Signals as Received" WWV and WWVH, CC1R Study Groups, 1956-1959, Subject: Question #141, Doc. VII, Date February 20, 1958.

Proceedings IRE, "Adjustments of High Precision Frequency and Time Standards", Vol. 38, pp 6, 15 January 1950.

Precision Measurement and Calibration Electricity and Electronics, Handbook 77, Vol. 1, U. S. Dept. of Commerce, National Bureau of Standards.

SECTION IV

THEORY OF OPERATION

GENERAL

As shown on the block diagram, figure 5, the Model RFH-1 is a single conversion, crystal controlled, superheterodyne receiver. The incoming signal is amplified by one stage of RF, Q1, and mixed with the output of the crystal oscillator Q10 at the mixer Q2. The 455 KC IF output of Q2 is amplified by three IF amplifiers Q3, Q4, and Q5 and fed to the audio detector Q6. The audio output of detector Q6 is delivered to the speaker through the audio amplifier Q7, driver Q8, and output stage Q9.

When an unknown oscillator is being compared to the transmitted signal, the oscillator output is fed to the input of RF amplifier Q1 through diode network CR1. The diode network produces usable harmonics for comparison purposes.

The input circuit to IF amplifier Q3 is a ceramic filter which provides a fixed tuned circuit and excellent selectivity. The filter fixes the IF frequency and minimizes the IF alignment procedure.

AGC voltage, developed in the detector circuit of Q6 is applied to RF amplifier Q1 and the first IF amplifier Q3. The AGC circuit maintains an output of ±10 db with 10 to 30,000 microvolt changes in signal level.

DETAIL DESCRIPTION. (See schematic diagram, figure 6.)

RF AMPLIFIER. The RF amplifier Q1 uses two input and two output tuned circuits to provide high rejection to image frequencies and spurious responses. Separate sets of tuned circuits are provided for each frequency and selected by FREQ MC switch S1. Each of

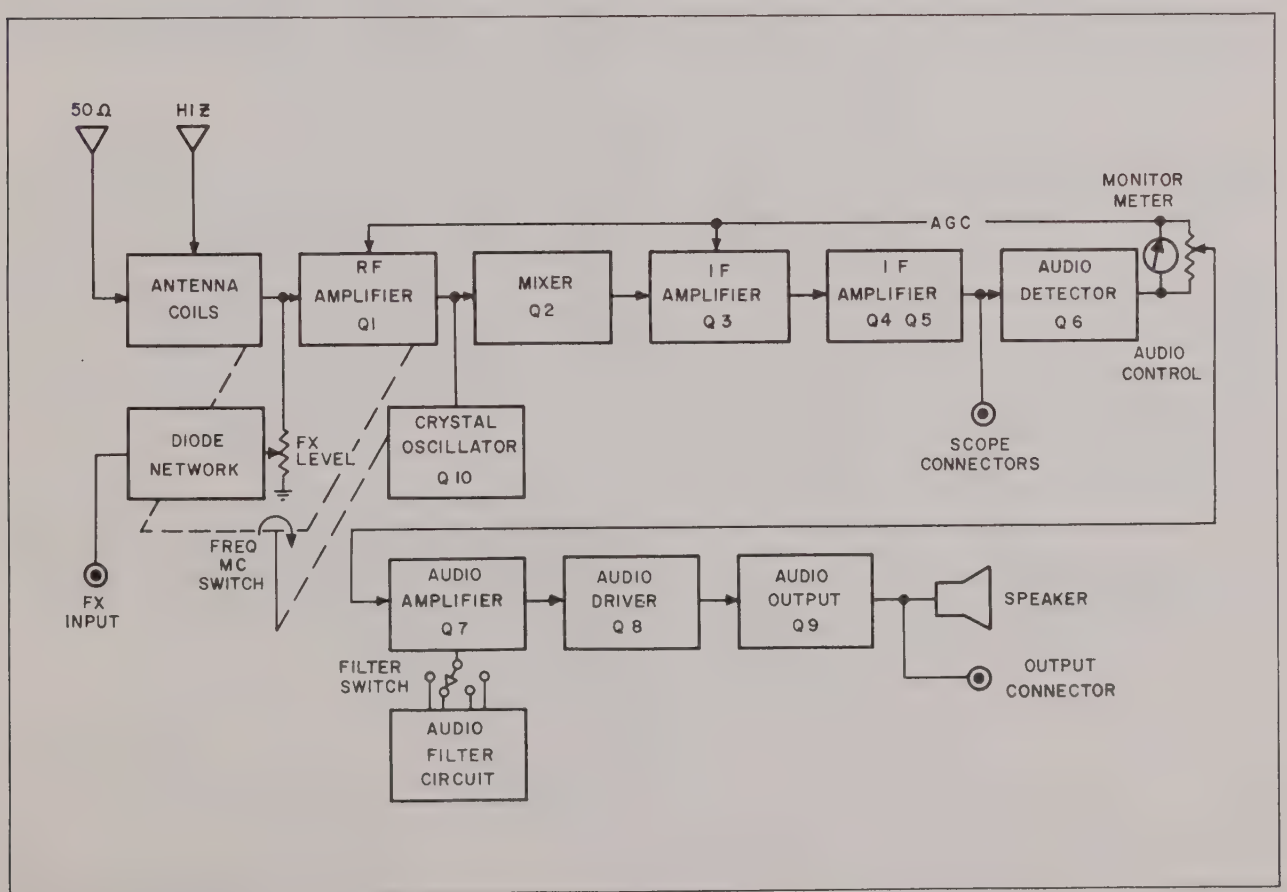


Figure 5. Block Diagram

the circuits is tuned by an adjustable transformer (T1 through T24). When a wire antenna is used, the antenna is tuned with ANT TRIM capacitor C56. AGC voltage, developed across AUDIO resistor R38, is applied to the emitter of Q1 through resistor R8. Capacitor C19 is selected to neutralize the input amplifier.

When an unknown oscillator frequency is being compared, the signal is applied through f_X INPUT jack J3, diode CR1, and f_X LEVEL resistor R1 to the base of Q1. f_X LEVEL resistor R1 is used to adjust the output level of the unknown oscillator to approximately that of the received frequency.

MIXER CIRCUIT. The signal from the RF amplifier Q1 and the local oscillator are applied to the base of mixer Q4 through capacitor C62. The IF difference frequency 455 KC is developed in the collector and delivered to the IF amplifiers Q3, Q4, and Q5 through transformer T31 and filter FL1. The transformer T31 couples the output of the mixer to the input of filter FL1. Filter FL1 is a sealed ceramic unit which provides a fixed tuned circuit for 455 KC.

LOCAL OSCILLATOR. The local crystal-controlled oscillator Q10 operates in the grounded base configuration, with capacitor C87 holding the base to ground for AC potentials. A low L/C ratio tank circuit (capacitors C43 through C48 and transformers T25 through T30) reduces harmonics. The transformers are adjustable to provide exact tuning of the tank circuit to the crystal frequency.

IF AMPLIFIERS. The 455 KC signal from filter FL1 is amplified by transistors Q3, Q4, and Q5 and delivered to the audio detector Q6 through transformer T32. AGC voltage is applied to the emitter of the first IF stage Q3 at the junction of resistors R17 and R18. Ceramic filters FL2 (connected across resistor R24) and FL3 (connected across resistor R30) are installed in the emitter circuits of transistors Q5 and Q6. These filters are series resonant and provide degeneration to any frequencies other than the 455 KC signal. As with the RF amplifier and the mixer, a portion of the emitter circuit is not by-passed to stabilize the stages. Resistor R23, in the emitter of transistor Q4, is selected to set the gain through the IF amplifiers. Transformer T32 matches impedances between transistor Q5 and the audio detector Q6.

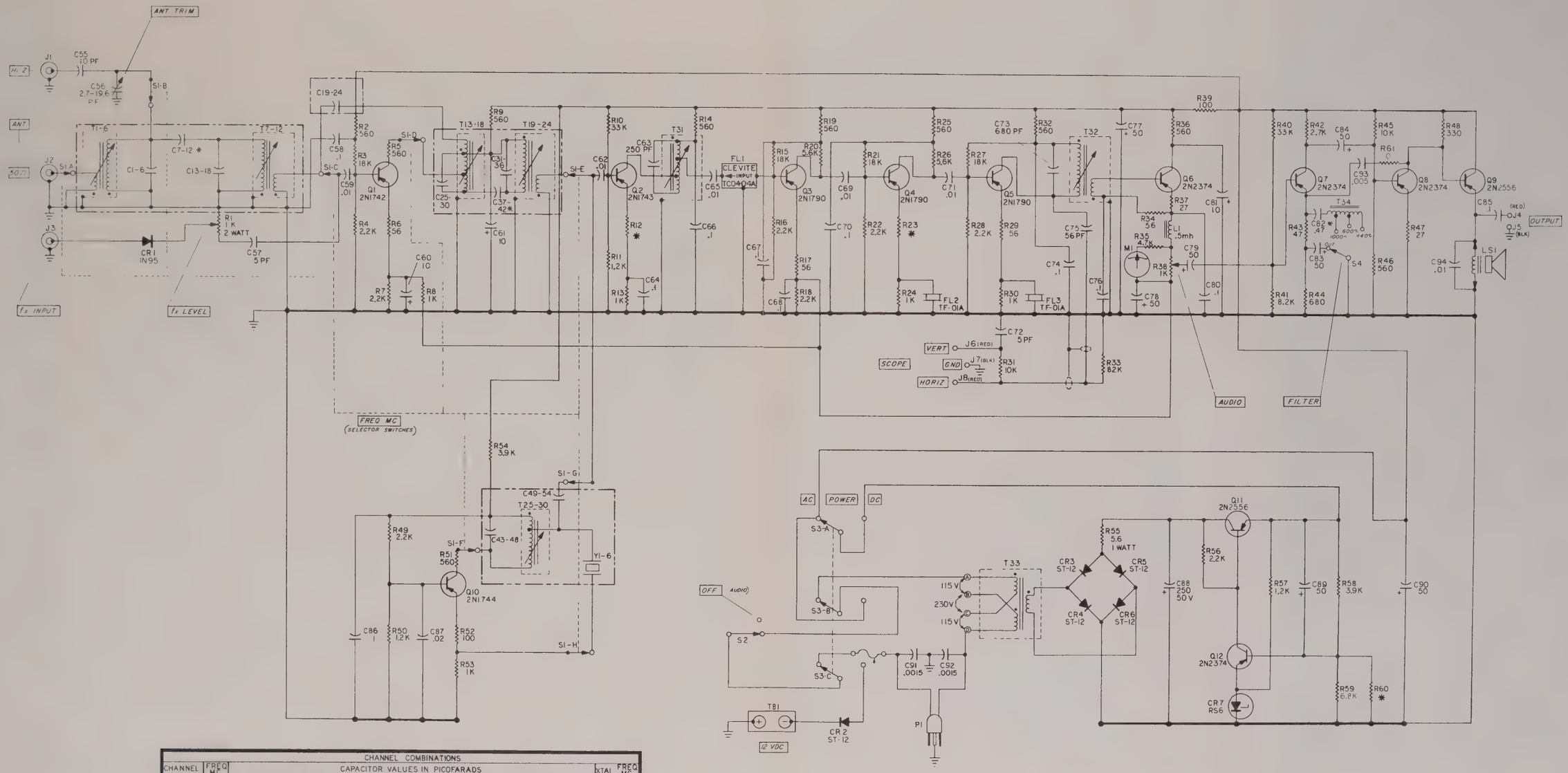
The SCOPE output jacks J6, J7, and J8 are tapped off the output of transistor Q5. The HORIZ output is supplied through capacitor C75. The VERT output is supplied through a 90° phase shift network composed of resistor R31 and capacitor C72.

AUDIO DETECTOR. Audio voltage is developed in the emitter circuit of transistor Q6. The audio voltage is supplied to audio amplifier Q7 by the arm of AUDIO level resistor R38. The monitor meter M1 is connected across resistor R38 and is used to indicate both relative signal strength and very low beat notes. Capacitor C78 removes the AC portion of the detected signal leaving a DC voltage for automatic gain control. The current drawn by the detector is proportional to the incoming carrier amplitude and is drawn through the emitter circuits of transistors Q1 and Q3. Increased carrier amplitude results in a larger voltage drop in the controlled stages and therefore reduced gain.

AUDIO AMPLIFIERS. The audio voltage from the arm of AUDIO level resistor R38 is delivered to the speaker SP1 through audio amplifiers Q7 and Q8 and the output transistor Q9. Audio FILTER switch S4 in the emitter circuit of Q7 selects one of three audio filter circuits. Capacitor C82 and transformer T34 provide a series resonant circuit to the selected audio frequency and is degenerative to all other frequencies. In the OUT position of the FILTER switch S4, the resonant circuit is switched out of the system and the audio response is from 20 to 3000 cps. The 100 ohm voice coil of speaker SP1 is connected in the emitter of transistor Q9 with the audio OUTPUT jacks J4 and J5 connected in parallel with the voice coil.

POWER SUPPLY. For operation from an AC power source, regulated 12 VDC power is developed in the self-contained power supply. The input AC power is stepped down by transformer T33 and the DC voltage is developed in the full wave bridge (CR3, CR4, CR5, and CR6). Regulation is provided by series transistor Q11 and amplifier Q12. Amplifier Q12 is referenced by zener diode CR7. For operation from a 115 VAC source, the primaries of transformer T33 are connected in parallel. For operation from a 230 VAC source, the 115 VAC jumpers are removed and a single jumper is installed which places the primaries in series.

For operation from a DC power source, POWER selector switch S3 is placed in the DC position and the power is supplied through diode CR2 and on-off switch S2 to capacitor C90. Diode CR2 prevents damage to the system if power is applied to terminal board TB1 with reversed polarity.



CHANNEL COMBINATIONS

CHANNEL	FREQ MC	CAPACITOR VALUES IN PICOFARADS																XTAL	FREQ MC
A	2.5	C1	180	C7 * 1		C13	180	C19	24	C25	180	C31	180	C37 * 1		C43	680	C49	56	Y1	2.955
B	5.0	C2	150	C8 * 1		C14	150	C20	15	C26	150	C32	150	C38 * 1		C44	330	C50	27	Y2	4.545
C	10	C3	120	C9 * 2		C15	120	C21	15	C27	120	C33	120	C39 * 2		C45	150	C51	24	Y3	9.545
D	15	C4	100	C10 * 1		C16	100	C22	10	C28	100	C34	120	C40 * 1		C46	100	C52	10	Y4	14.545
E	20	C5	82	C11 * 2		C17	82	C23	5	C29	82	C35	82	C41 * 2		C47	75	C53	10	Y5	19.545
F	25	C6	75	C12 * 1		C18	75	C24	3	C30	75	C36	75	C42 * 1		C48	68	C54	5	Y6	24.545

F1
.2 AMP 115V OPR
.1 AMP 230V OPR

GENERAL NOTES: UNLESS OTHERWISE SPECIFIED,

1. CIRCUITRY WITHIN AREAS (3) BORDERED BY ——-·——-·—— LINES REPRESENT ONLY ONE CHANNEL. CIRCUITS FOR ALL CHANNELS (A THRU F) ARE IDENTICAL, EXCEPT FOR CAPACITOR AND CRYSTAL VALUES AS TABULATED IN "CHANNEL COMBINATIONS" TABLE.
2. ALL RESISTORS ARE $\frac{1}{4}$ WATT, ±10%, WITH VALUES IN OHMS.
3. CAPACITOR VALUES ARE IN MICROFARADS, WITH ELECTROLYTIC CAPACITORS RATED AT 15 VWDC.
4. ASTERISK SYMBOL (*) INDICATES SELECTED VALUE (MAY EVEN BE OMITTED).
5. R61 ON UNITS SER 1358 & UP.

Figure 6. Schematic Diagram

SECTION V

MAINTENANCE

SCHEDULED MAINTENANCE

Once every three months, the unit should be checked for mechanical defects, such as damaged components or insulation, loose hardware, etc. Once every year, the unit should be cleaned using a vacuum cleaner. No other scheduled maintenance is recommended. Refer to Section VI for test and alignment procedures.

PARTS REPLACEMENT

Gertsch Products will supply replacement components at current net prices. However, a large majority of the components are standard electronic parts obtainable from your local electronics parts dealer. Make certain of the required tolerances by consulting the parts list.

Whenever transistor Q1 is changed, neutralize the RF circuit as follows:

1. With the transistor removed, connect a 0.6 pf capacitor from the junction of resistors R3 and R4 to resistor R5.
2. Replace capacitor C19 with a decade capacitor set to approximately 15 pf.
3. Set FREQ MC switch to 2.5 megacycle position.
4. Align RF stage as outlined under ALIGNMENT procedure in Section VI.
5. Adjust decade capacitor to obtain a minimum (or null) output.
6. Remove decade capacitor and install a fixed capacitor with the value obtained in step 5.
7. Repeat procedure for all frequency channels.
8. Install transistor Q1 and recheck alignment.

SECTION VI

TEST AND ALIGNMENT PROCEDURES

EQUIPMENT REQUIRED

To perform the test and alignment procedures, the following test equipment is required:

1. Signal generator for the following frequencies:

   455 KC, 2.5, 5, 10, 15 MC, 20 and 25 megacycles.

2. AC vacuum tube voltmeter.

TEST PROCEDURE

Once a year, or whenever substandard performance is suspected, test the sensitivity and selectivity of unit as follows:

SENSITIVITY

1. Connect VTVM to the OUTPUT jacks.
2. Turn FREQ MC switch to 2.5 position.
3. Inject a 2.5 mc, 3 microvolt signal modulated 30% at 1000 cycles into the 50 ohm antenna input jack.
4. Turn FILTER switch to OUT.
5. Turn AUDIO control to maximum output.
6. Check that VTVM indicates a voltage of 3.3 volts, or more.
7. Repeat procedure for each frequency channel.

SELECTIVITY

1. Connect VTVM to the OUTPUT jacks.
2. Inject a 455 KC signal modulated 30% at 1000 cycles into the base of Q2. The most convenient method is to apply the signal at the index of switch S4.

NOTE

If a 3 volt input signal is available, apply signal to 50 ohm antenna input and turn FREQ MC switch to 2.5.

3. Turn FILTER switch to OUT.

4. Adjust AUDIO control and input signal level to obtain a measurable signal on the VTVM.

5. Vary input signal frequency to 453 KC.

6. Check that output signal decreases by at least 6 db (VTVM indication decreases 1/2) from step 4.

7. Vary input signal frequency to 457 KC.

8. Check that output signal decreases by at least 6 db from step 4.

ALIGNMENT PROCEDURE

IF ALIGNMENT. (See figure 7.)

1. Connect VTVM to the OUTPUT jacks.

2. Inject a 455 KC, 6 microvolt signal modulated 30% at 1000 cycles into the base of Q2.

3. Adjust transformer T31 for maximum audio output.

4. Adjust transformer T32 for maximum audio output.

5. After alignment, the audio output should be 100 milliwatts or more.

RF ALIGNMENT. (See figure 7.)

1. Turn FREQ MC switch to the 25 megacycle position.

2. Inject a 25 mc signal modulated 30% at 1000 cycles into the 50 ohm antenna input jack.

3. Adjust 25 megacycle channel transformers for maximum audio output in the following order: T30, T24, T18, T12, and T6.

4. Set input signal level to 3 microvolt and check that VTVM indicates 3.3 volts or more.

5. Repeat above procedure for remaining frequency channels.

TROUBLE SHOOTING

Refer to Table III for normal transistor DC voltages. Refer to Table IV for normal stage gains. All stage gain measurements should be made under the following conditions:

1. AUDIO control fully clockwise.

2. FILTER switch in the OUT position.

3. FREQ MC switch in the 15 megacycle position.

TABLE III. NORMAL TRANSISTOR DC VOLTAGES

TRANSISTOR	BASE	DC VOLTAGES	
		COLLECTOR	EMITTER
Q1	1.5	11	1.4
Q2	0.4	11	0.22
Q3	1.2	10	1
Q4	1.1	6	0.9
Q5	1	11	0.8
Q6	1.3	11	1.3
Q7	2.3	4.4	2.2
Q8	0.54	6.2	0.48
Q9	6.5	12	6.5
Q10	1.3	6.6	1.1
Q11	12.5	29	12
Q12	6.8	12.5	6.7

TABLE IV. NORMAL STAGE GAINS

INPUT SIGNAL	TRANSISTOR (Apply signal to base)	AUDIO OUTPUT VOLTAGE
15 MC, 0.8 to 1 UV, modulated 30% at 400 cps	Q1	3.3
15 MC, 3 to 4 UV, modulated 30% at 400 cps	Q2	3.3
455 KC, 1.3 to 1.5 UV, modulated 30% at 400 cps	Q3	3.3
455 KC, 15.5 to 17 UV, modulated 30% at 400 cps	Q4	3.3
455 KC, 660 to 700 UV, modulated 30% at 400 cps	Q5	3.3
455 KC, 47 to 52 millivolts modulated 30% at 400 cps	Q6	3.3

SECTION VII

PARTS LIST

NOTE: Items marked with an asteriks (*) are factory selected parts. In some cases, these parts may be omitted.

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
C1	8	Capacitor, mica, 180 pf ±5%, 300 vdcw	Elmenco	DM15E181J
C2	8	Capacitor, mica, 150 pf ±5%, 300 vdcw	Elmenco	DM15E151J
C3	8	Capacitor, mica, 120 pf ±5%, 300 vdcw	Elmenco	DM15E121J
C4	8	Capacitor, mica, 100 pf ±5%, 300 vdcw	Elmenco	DM15E101J
C5	8	Capacitor, mica, 82 pf ±5%, 300 vdcw	Elmenco	DM15E820J
C6	8	Capacitor, mica, 75 pf ±5%, 300 vdcw	Elmenco	DM15E750J
C7	8	Capacitor, mica, 3 pf ±5%, 300 vdcw	Elmenco	DM15E030J
C8	8	Capacitor, mica, 1 pf ±5%, 300vdcw	Elmenco	DM15E010J
C9	8	Capacitor, mica, 2 pf ±5%, 300 vdcw	Elmenco	DM15E020J
C10	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C11	8	Capacitor, mica, 2 pf ±5%, 300 vdcw	Elmenco	DM15E020J
C12	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C13	8	Capacitor, mica, 180 pf ±5%, 300 vdcw	Elmenco	DM15E181J
C14	8	Capacitor, mica, 150 pf ±5%, 300 vdcw	Elmenco	DM15E151J
C15	8	Capacitor, mica, 120 pf ±5%, 300 vdcw	Elmenco	DM15E121J
C16	8	Capacitor, mica, 100 pf ±5%, 300 vdcw	Elmenco	DM15E101J
C17	8	Capacitor, mica, 82 pf ±5%, 300 vdcw	Elmenco	DM15E820J
C18	8	Capacitor, mica, 75 pf ±5%, 300 vdcw	Elmenco	DM15E750J
C19	8	Capacitor, mica, 24 pf ±5%, 300 vdcw	Elmenco	DM15E240J
C20	8	Capacitor, mica, 15 pf ±5%, 300 vdcw	Elmenco	DM15E150J

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
C21	8	Capacitor, mica, 15 pf ±5%, 300 vdcw	Elmenco	DM15E150J
C22	8	Capacitor, mica, 10 pf ±5%, 300 vdcw	Elmenco	DM15E100J
C23	8	Capacitor, mica, 5 pf ±5%, 300 vdcw	Elmenco	DM15E050J
C24	8	Capacitor, mica, 3 pf ±5%, 300 vdcw	Elmenco	DM15E030J
C25	8	Capacitor, mica, 180 pf ±5%, 300 vdcw	Elmenco	DM15E181J
C26	8	Capacitor, mica, 150 pf ±5%, 300 vdcw	Elmenco	DM15E151J
C27	8	Capacitor, mica, 120 pf ±5%, 300 vdcw	Elmenco	DM15E121J
C28	8	Capacitor, mica, 100 pf ±5%, 300 vdcw	Elmenco	DM15E101J
C29	8	Capacitor, mica, 82 pf ±5%, 300 vdcw	Elmenco	DM15E820J
C30	8	Capacitor, mica, 75 pf ±5%, 300 vdcw	Elmenco	DM15E750J
C31	8	Capacitor, mica, 180 pf ±5%, 300 vdcw	Elmenco	DM15E181J
C32	8	Capacitor, mica, 150 pf ±5%, 300 vdcw	Elmenco	DM15E151J
C33	8	Capacitor, mica, 120 pf ±5%, 300 vdcw	Elmenco	DM15E121J
C34	8	Capacitor, mica, 100 pf ±5%, 300 vdcw	Elmenco	DM15E101J
C35	8	Capacitor, mica, 82 pf ±5%, 300 vdcw	Elmenco	DM15E820J
C36	8	Capacitor, mica, 75 pf ±5%, 300 vdcw	Elmenco	DM15E750J
C37	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C38	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C39	8	Capacitor, mica, 2 pf ±5%, 300 vdcw	Elmenco	DM15E020J
C40	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C41	8	Capacitor, mica, 2 pf ±5%, 300 vdcw	Elmenco	DM15E020J
C42	8	Capacitor, mica, 1 pf ±5%, 300 vdcw	Elmenco	DM15E010J
C43	8	Capacitor, mica, 680 pf ±5%, 200 vdcw	Elmenco	DM15E681J
C44	8	Capacitor, mica, 330 pf ±5%, 300 vdcw	Elmenco	DM15E331J
C45	8	Capacitor, mica, 150 pf ±5%, 300 vdcw	Elmenco	DM15E151J
C46	8	Capacitor, mica, 110 pf ±5%, 300 vdcw	Elmenco	DM15E111J
C47	8	Capacitor, mica, 75 pf ±5%, 300 vdcw	Elmenco	DM15E750J
C48	8	Capacitor, mica, 68 pf ±5%, 300 vdcw	Elmenco	DM15E680J
C49	8	Capacitor, mica, 56 pf ±5%, 300 vdcw	Elmenco	DM15E560J
C50	8	Capacitor, mica, 27 pf ±5%, 300 vdcw	Elmenco	DM15E270J
C51	8	Capacitor, mica, 24 pf ±5%, 300 vdcw	Elmenco	DM15E240J
C52	8	Capacitor, mica, 10 pf ±5%, 300 vdcw	Elmenco	DM15E100J
C53	8	Capacitor, mica, 10 pf ±5%, 300 vdcw	Elmenco	DM15E100J
C54	8	Capacitor, mica, 5 pf ±5%, 300 vdcw	Elmenco	DM15E050J
C55	7	Capacitor, mica, 10 pf ±5%, 300 vdcw	Elmenco	DM15E100J
C56	4	Capacitor, variable, 2.7 to 19.6 pf	E. F. Johnson	160-110
C57	8	Capacitor, mica, 5 pf ±5%, 300 vdcw	Elmenco	DM15E050J
C58	8	Capacitor, paper, 0.1 uf ±20%, 100 vdcw	Elpac, Inc.	VZ1N104
C59	8	Capacitor, ceramic, 0.01 uf, 300 vdcw	Erie	851Z5U103Z
C60	8	Capacitor, electrolytic, 10 uf, 15 vdcw	Sprague	VL1167
C61	8	Capacitor, electrolytic, 10 uf, 15 vdcw	Sprague	VL1167
C62	8	Capacitor, ceramic, 0.01 uf, 300 vdcw	Erie	851Z5U103Z
C63	8	Capacitor, mica, 250 pf ±5%, 300 vdcw	Elmenco	DM15E251J
C64	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C65	8	Capacitor, ceramic, 0.01 uf, 300 vdcw	Erie	851Z5U103Z
C66	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C67	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C68	8	Capacitor, ceramic, 0.1 uf, 200 vdcw	Erie	827Z5V104P
C69	8	Capacitor, ceramic, 0.01 uf, 300 vdcw	Erie	851Z5U103Z

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
C70	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C71	8	Capacitor, ceramic, 0.01 uf, 300 vdcw	Erie	851Z5U103Z
C72	7	Capacitor, mica, 5 pf ±5%, 300 vdcw	Elmenco	DM15E050J
C73	8	Capacitor, mica, 680 pf ±5%, 300 vdcw	Elmenco	DM15E681J
C74	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C75	8	Capacitor, mica, 56 pf ±5%, 300 vdcw	Elmenco	DM15E560J
C76	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C77	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C78	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C79	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C80	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C81	8	Capacitor, electrolytic, 10 uf, 15 vdcw	Sprague	VL1167
C82	8	Capacitor, paper, 0.47 uf ±5%, 100 vdcw	Elpac, Inc.	VZ1N474-SPCT
C83	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C84	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C85	8	Capacitor, paper, 0.1 uf ±20%, 100 vdcw	Elpac, Inc.	VZ1N104
C86	8	Capacitor, ceramic, 0.1 uf, 300 vdcw	Erie	827Z5V104P
C87	8	Capacitor, ceramic, 0.02 uf, 300 vdcw	Erie	811Z5U203Z
C88	8	Capacitor, electrolytic, 250 uf, 50 vdcw	Sprague	TVA1312
C89	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C90	8	Capacitor, electrolytic, 50 uf, 15 vdcw	Sprague	VL1174
C91	8	Capacitor, ceramic, 0.0015 uf, 300 vdcw	Erie	831Z5U152P
C92	8	Capacitor, ceramic, 0.0015 uf, 300 vdcw	Erie	831Z5U152P
C93	8	Capacitor, ceramic, 0.005 uf	Erie	831Z5U502Z
C94	7	Capacitor, ceramic, .01 uf	Erie	851Z5U103Z
CR1	9	Diode	Hughes	1N95
CR2	9	Diode, silicon	Sarkes-Tarzian	ST12
CR3	9	Diode, silicon	Sarkes-Tarzian	ST12
CR4	9	Diode, silicon	Sarkes-Tarzian	ST12
CR5	9	Diode, silicon	Sarkes-Tarzian	ST12
CR6	9	Diode, silicon	Sarkes-Tarzian	ST12
CR7	9	Diode, zener	Hoffman	RS6
F1	7	Fuse, 0.2 amp, 115v opr	Bussmann	MDL2-10
F1	7	Fuse, 0.1 amp, 230v opr	Bussmann	MDL1-10
FL1	7	Filter	Clevite	TC04-04A
FL2	7	Filter	Clevite	TF01A
FL3	7	Filter	Clevite	TF01A
J1	4	Connector, BNC		UG604/U
J2	4	Connector, BNC		UG604/U
J3	4	Connector, BNC		UG657/U
J4	4	Jack, banana, red	E. F. Johnson	108-902
J5	4	Jack, banana, black	E. F. Johnson	108-903
J6	4	Jack, banana, red	E. F. Johnson	108-902
J7	4	Jack, banana, black	E. F. Johnson	108-903
J8	4	Jack, banana, red	E. F. Johnson	108-902
L1	7	Inductor, 0.5 mh	Gertsch	LS7B
LS1	4	Speaker	Quam	22A06Z100

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
M1	4	Meter, panel, 0-100UA	Gertsch	MA13
P1	4	Plug, p/o power cable	Belden	17406S
Q1	7	Transistor, germanium, PNP	Philco	2N1742
Q2	7	Transistor, germanium, PNP	Philco	2N1743
Q3	7	Transistor, germanium, PNP	Philco	2N1790
Q4	7	Transistor, germanium, PNP	Philco	2N1790
Q5	7	Transistor, germanium, PNP	Philco	2N1790
Q6	7	Transistor, germanium, PNP	Philco	2N2374
Q7	7	Transistor, germanium, PNP	Philco	2N2374
Q8	7	Transistor, germanium, PNP	Philco	2N2374
Q9	7	Transistor, germanium, PNP	Texas Instruments	2N2556
Q10	7	Transistor, germanium, PNP	Philco	2N1744
Q11	7	Transistor, germanium, PNP	Texas Instruments	2N2556
Q12	7	Transistor, germanium, PNP	Philco	2N2374
R1	4	Resistor, variable, 1K, 2W	Gertsch	RV63
R2	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R3	9	Resistor, composition, 18K ±10%, 1/4W	Allen Bradley	CB1831
R4	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
R5	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R6	9	Resistor, composition, 56 ohms ±10%, 1/4W	Allen Bradley	CB5601
R7	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
R8	9	Resistor, composition, 1K ±10%, 1/4W	Allen Bradley	CB1021
R9	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R10	9	Resistor, composition, 33K ±10%, 1/4W	Allen Bradley	CB3331
R11	9	Resistor, composition, 1.2K ±10%, 1/4W	Allen Bradley	CB1221
R12	9	Resistor, composition, 1/4W (jumpers may be used)		
R13	9	Resistor, composition, 1K ±10%, 1/4W	Allen Bradley	CB1021
R14	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R15	9	Resistor, composition, 18K ±10%, 1/4W	Allen Bradley	CB1831
R16	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
R17	9	Resistor, composition, 56 ohms ±10%, 1/4W	Allen Bradley	CB5601
R18	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
R19	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R20	9	Resistor, composition, 5.6K ±10%, 1/4W	Allen Bradley	CB5621
R21	9	Resistor, composition, 18K ±10%, 1/4W	Allen Bradley	CB1831
R22	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
*R23	9	Resistor, composition, 1/4W (jumper may be used)		
R24	9	Resistor, composition, 1K ±10%, 1/4W	Allen Bradley	CB1021
R25	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R26	9	Resistor, composition, 5.6K ±10%, 1/4W	Allen Bradley	CB5621
R27	9	Resistor, composition, 18K ±10%, 1/4W	Allen Bradley	CB1831
R28	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
R29	9	Resistor, composition, 56 ohms ±10%, 1/4W	Allen Bradley	CB5601
R30	9	Resistor, composition, 1K ±10%, 1/4W	Allen Bradley	CB1021
R31	7	Resistor, composition, 10K ±10%, 1/4W	Allen Bradley	CB1031
R32	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R33	9	Resistor, composition, 82K ±10%, 1/4W	Allen Bradley	CB8231
R34	9	Resistor, composition, 56 ohms ±10%, 1/4W	Allen Bradley	CB5601
R35	9	Resistor, composition, 4.7K ±10%, 1/4W	Allen Bradley	CB4721
R36	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R37	9	Resistor, composition, 27 ohms ±10%, 1/4W	Allen Bradley	CB2701
R38	4	Resistor, variable, composition, 1K, 2W	Gertsch	RV62
R39	9	Resistor, composition, 100 ohms ±10%, 1/4W	Allen Bradley	CB1011
R40	9	Resistor, composition, 33K ±10%, 1/4W	Allen Bradley	CB3331
R41	9	Resistor, composition, 8.2K ±10%, 1/4W	Allen Bradley	CB8221
R42	9	Resistor, composition, 2.7K ±10%, 1/4W	Allen Bradley	CB2721
R43	9	Resistor, composition, 47 ohms ±10%, 1/4W	Allen Bradley	CB4701
R44	9	Resistor, composition, 680 ohms ±10%, 1/4W	Allen Bradley	CB6811
R45	9	Resistor, composition, 10K ±10%, 1/4W	Allen Bradley	CB1031
R46	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R47	9	Resistor, composition, 27 ohms ±10%, 1/4W	Allen Bradley	CB2701
R48	9	Resistor, composition, 330 ohms ±10%, 1/4W	Allen Bradley	CB3311
R49	9	Resistor, composition, 2.2K ±10%, 1/4W	Allen Bradley	CB2221
R50	9	Resistor, composition, 1.2K ±10%, 1/4W	Allen Bradley	CB1221
R51	9	Resistor, composition, 560 ohms ±10%, 1/4W	Allen Bradley	CB5611
R52	9	Resistor, composition, 100 ohms ±10%, 1/4W	Allen Bradley	CB1011
R53	9	Resistor, composition, 1K ±10%, 1/4W	Allen Bradley	CB1021
R54	9	Resistor, composition, 3.9K ±10%, 1/4W	Allen Bradley	CB3921
R55	9	Resistor, composition, 5.6 ohms ±10%, 1W	Allen Bradley	GB56G1
R56	9	Resistor, composition, 2.2K ±10±, 1/4W	Allen Bradley	CB2221
R57	9	Resistor, composition, 1.2K ±10%, 1/4W	Allen Bradley	CB1221
R58	9	Resistor, composition, 3.9K ±10%, 1/4W	Allen Bradley	CB3921
R59	9	Resistor, composition, 6.8K ±10%, 1/4W	Allen Bradley	CB6821
*R60	9	Resistor, composition (approximately 27K) 1/4W	Allen Bradley	CB2731
R61	9	Resistor, composition, 10 ohms ±10%, 1/4W	Allen Bradley	CB1001
S1	4	Switch	Gertsch	SW195
S2	4	Switch, SPST	Ohmite	CS1
S3	4	Switch, slide	Continental-Wirt	G769
S4	4	Switch, rotary	Gertsch	SW178
T1	7	Transformer, RF	Gertsch	TA297

SYMBOL	FIG.	DESCRIPTION	MANUFACTURER	PART NO.
T2	7	Transformer, RF	Gertsch	TA298
T3	7	Transformer, RF	Gertsch	TA299
T4	7	Transformer, RF	Gertsch	TA300
T5	7	Transformer, RF	Gertsch	TA301
T6	7	Transformer, RF	Gertsch	TA302
T7	7	Transformer, RF	Gertsch	TA303
T8	7	Transformer, RF	Gertsch	TA304
T9	7	Transformer, RF	Gertsch	TA305
T10	7	Transformer, RF	Gertsch	TA306
T11	7	Transformer, RF	Gertsch	TA307
T12	7	Transformer, RF	Gertsch	TA308
T13	7	Transformer, RF	Gertsch	TA309
T14	7	Transformer, RF	Gertsch	TA310
T15	7	Transformer, RF	Gertsch	TA311
T16	7	Transformer, RF	Gertsch	TA312
T17	7	Transformer, RF	Gertsch	TA313
T18	7	Transformer, RF	Gertsch	TA314
T19	7	Transformer, RF	Gertsch	TA303
T20	7	Transformer, RF	Gertsch	TA304
T21	7	Transformer, RF	Gertsch	TA305
T22	7	Transformer, RF	Gertsch	TA306
T23	7	Transformer, RF	Gertsch	TA307
T24	7	Transformer, RF	Gertsch	TA308
T25	7	Transformer, oscillator	Gertsch	TA315
T26	7	Transformer, oscillator	Gertsch	TA316
T27	7	Transformer, oscillator	Gertsch	TA317
T28	7	Transformer, oscillator	Gertsch	TA318
T29	7	Transformer, oscillator	Gertsch	TA319
T30	7	Transformer, oscillator	Gertsch	TA320
T31	7	Transformer, IF	Gertsch	TA321
T32	7	Transformer, IF	Gertsch	TA322
T33	7	Transformer, power	Gertsch	TA324
T34	7	Transformer, filter	Gertsch	TA323
TB1	4	Terminal board	Cinch	17-2
TB2	7	Terminal strips	Cinch	52A
XF1	7	Fuseholder (2 reqd)	Bussmann	4405
Y1	7	Crystal 2.955 megacycle	Gertsch	YC7
Y2	7	Crystal 4.545 megacycle	Gertsch	YC8
Y3	7	Crystal 9.545 megacycle	Gertsch	YC9
Y4	7	Crystal 14.545 megacycle	Gertsch	YC10
Y5	7	Crystal 19.545 megacycle	Gertsch	YC11
Y6	7	Crystal 24.545 megacycle	Gertsch	YC12
		Knob, bar	Gertsch	AC95-1
		Knob, medium	Gertsch	AC92-3
		Knob, small (3 reqd)	Lerco	100-1
		Adapter plug	Belden	5272

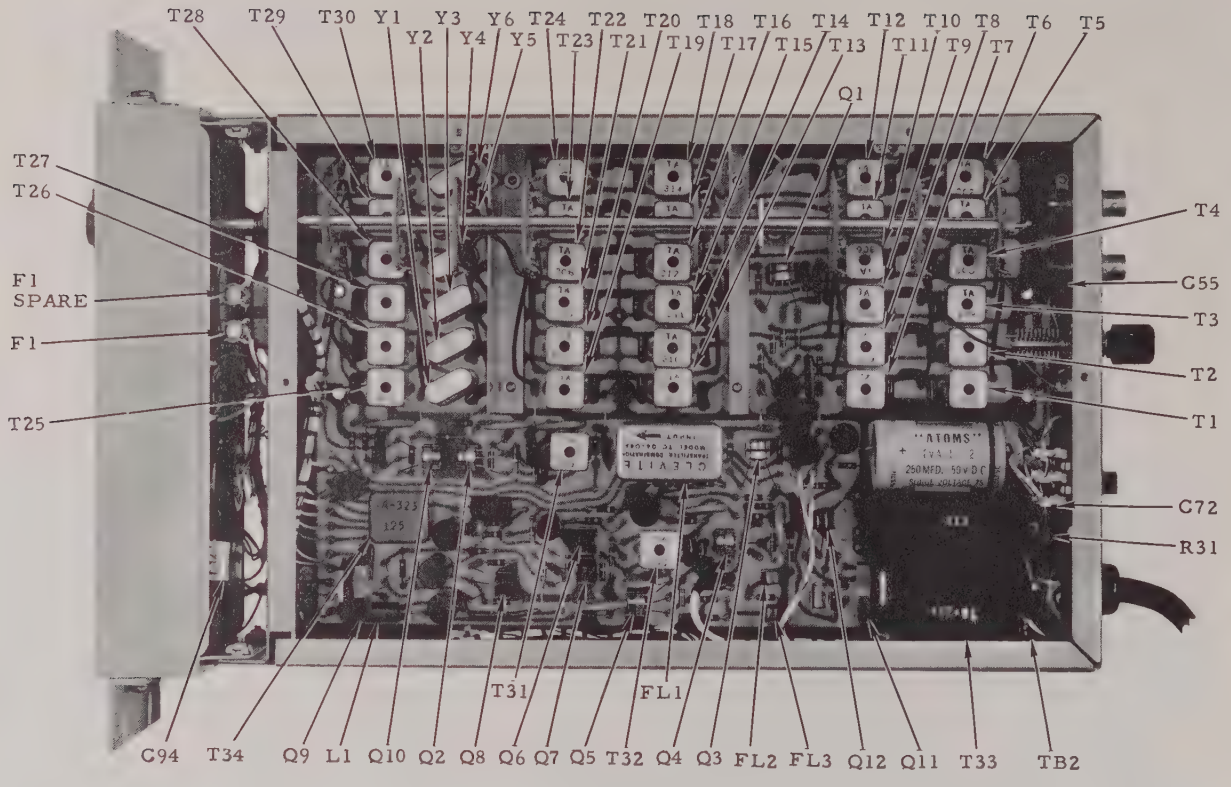


Figure 7. Chassis Layout

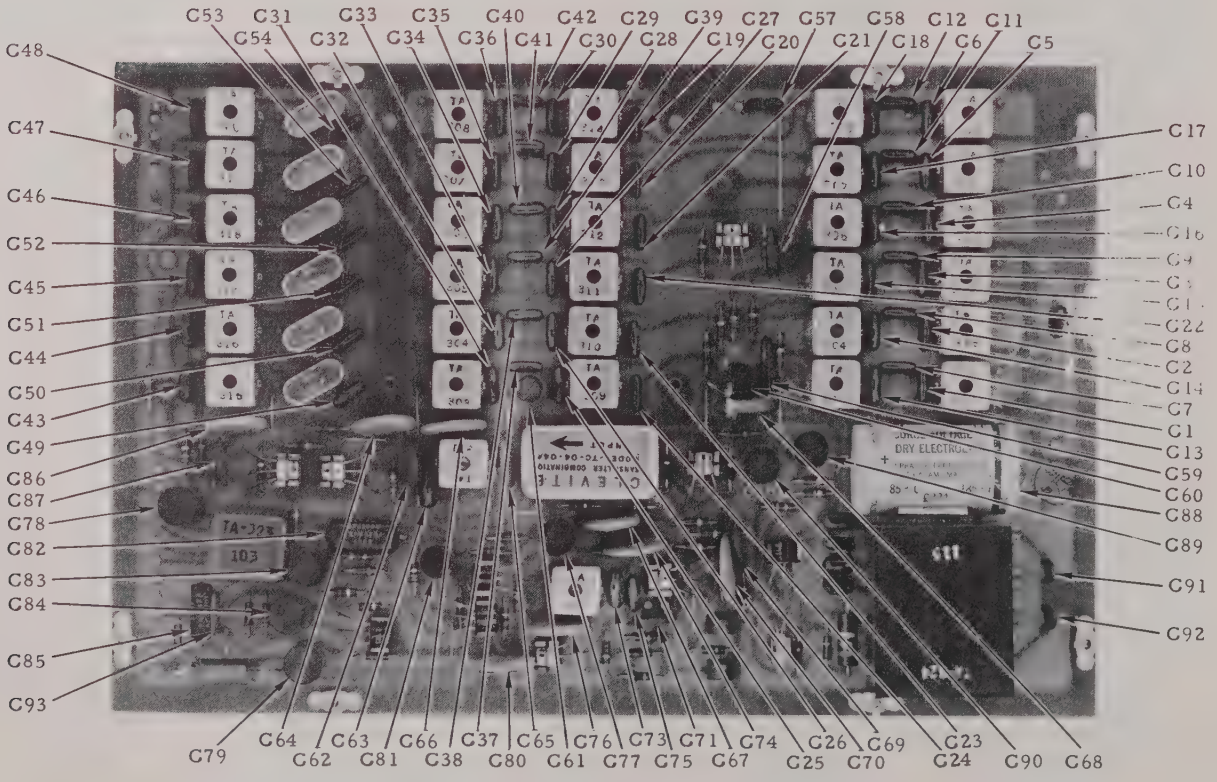


Figure 8. Capacitor Locations

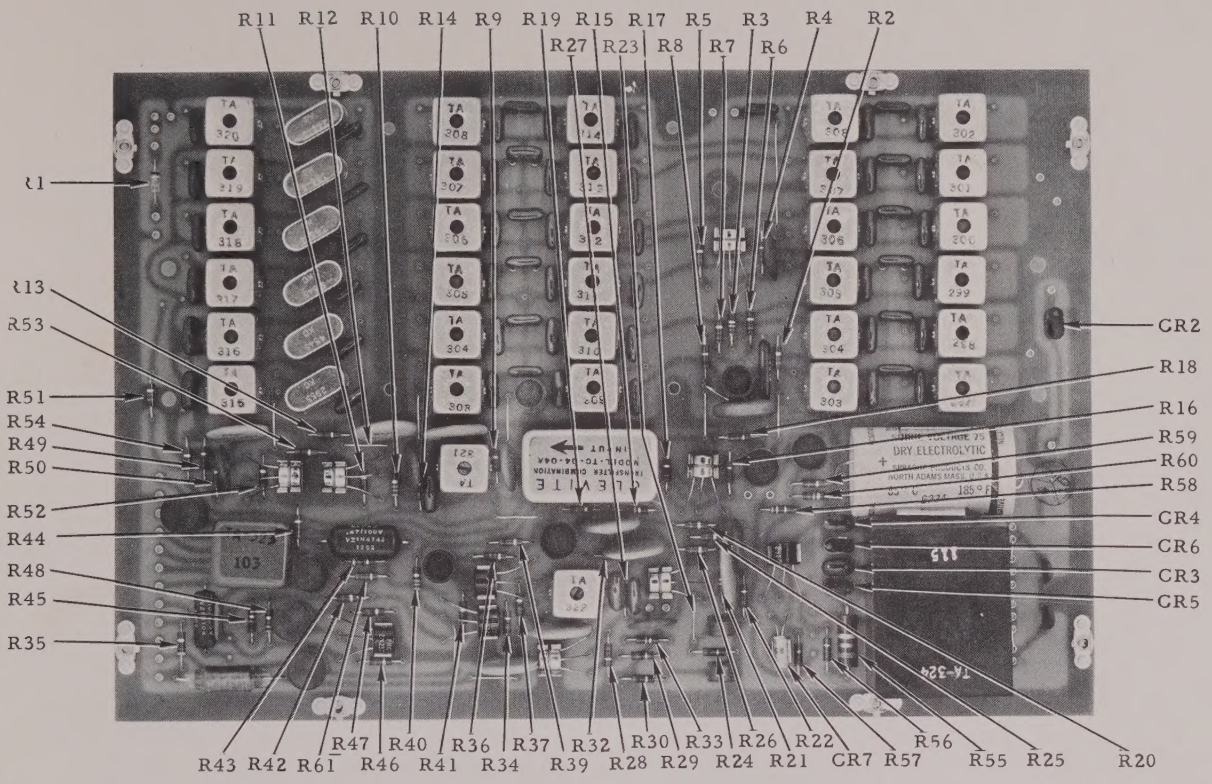


Figure 9. Resistor and Diode Locations

MP MASTER
MA33980